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CSERIAC GATEWAY

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CSERIAC is a United States Department of Defense Information Analysis Center administered by the Defense Technical Information Center, Ft. Belvoir, VA, technically managed by the Armstrong Laboratory Human Engineering Division, Wright-Patterson Air Force Base, OH, and operated by the University of Dayton Research Institute, Dayton, OH.

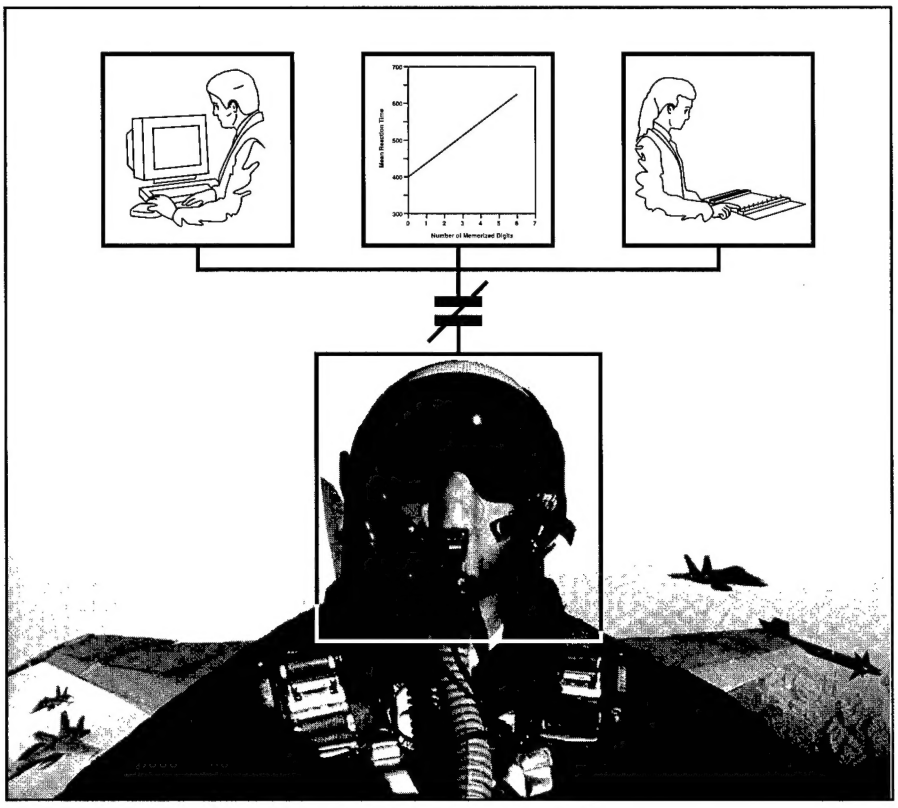

Figure 1. The experience of a pilot in an aircraft, or for that matter, any member of a crew system, cannot be captured by simply summing the results of a variety of research studies conducted in laboratories under conditions devoid of context.

Situation Awareness: In Search of Meaning

John M. Flach

The term "situation awareness" (SA) originated with pilots as they attempted to articulate the difficulties of air combat. The experience of fully understanding what was going on, of seeing each element within the context of the mission, of having all the pieces fit into a coherent picture was described as high SA. The experience of being lost, of a jumbled complex of elements with no apparent coherence was described as loss of SA. These experiences are real and most of us have experienced both ends of this continuum in various phases of our lives (e.g., in sports, music, or driving). We have had the experience of being "on top of things," being in complete control, and we have had the experience of being "lost," being out of control.

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Question 1: Can complex systems, such as tactical aircraft, be designed to ensure or at least enhance the probability of high or at least satisfactory situation awareness?

Question 2: What do basic research programs on human performance and cognition offer for understanding situation awareness?

Question 1 is a challenge that has been addressed to the human factors community, in particular by the upper command levels within the Air Force. The answer to this question is clearly YES. There is ample evidence from research on problem solving and creativity that changes in how a problem is presented have enormous impact on the probability of insightful solutions. For example, Wertheimer (1959) has shown that the way a problem is presented to a subject has a clear impact on the "structural understanding" that results. With one presentation creative solutions result; with another presentation, only rote solutions emerge. For complex systems, the human operators' understanding of a problem can be greatly influenced by the design of the interface–the displays, controls, and their relations. Without consideration for the human operators, interfaces in complex systems often evolve to become jumbled, disconnected fields of data. Such displays place the burden of integration necessary to produce clear assessments of the situation on the human operator. Cognitive engineering has made great progress in studying ways in which interfaces can be designed to facilitate the integration necessary to produce clear assessments. There is ample evidence from laboratory and applied research of the impact that such interventions can have on human performance (e.g., Bennett & Flach, 1992; Rasmussen & Vicente, 1989; Wickens & Carswell, 1995; Woods, 1991).

The mental representation of a problem and the resulting awareness are also clearly influenced by the training or expertise of an individual. Again, there is clear evidence in the cognitive literature that experts "chunk" or group information more effectively and that they organize the information necessary to solve problems more effectively than do novices. Thus, the design of training systems can have great potential for influencing situation awareness in operational settings. Cognitive engineering can contribute here both through knowledge elicitation (to help identify the types of representations that experts use) and through the design of training protocols (to facilitate the discovery and utilization of effective representations) (e.g., Young & McNeese, 1995).

Thus in response to Question 1, it is clear that human factors has always been concerned with aspects of design that influence situation awareness. Situation awareness may be a new way to articulate concerns about human performance. These concerns may be amplified because complexity in modern work domains, such as air combat, is at unprecedented levels. However, making sure that the human operator has the resources (in terms of interfaces and training) to make informed control decisions has always been central to the human factors enterprise. Although it is not possible to guarantee high SA under all circumstances in complex work environments, much is known about general factors that impact situation awareness. Human factors professionals who are knowledgeable about a work domain can generally have a positive impact on designing to support situation awareness.

So, if human factors has been addressing problems of situation awareness all along, why does this construct seem so novel? Why the excitement? Why the controversy? I think that this has a lot to do with Question 2 above. The basic science of psychology and human performance, generally considered to be the foundation upon which human factors stands, is largely a science of nonsense syllables. It is a science built on tasks that were chosen using much the same rationale that Ebbinghaus used for studying memory for nonsense syllables. It is a science where meaning has been considered a confounding factor, not an integral part of the problem. If you doubt this, I challenge you to pick up a standard text on human performance theory and find a reference to meaning. It won't be there!

What a terrible struggle our field [psychology] has had just to overcome the nonsense syllable! Decades to discover the 'meaningfulness' of nonsense syllables, and decades more to finally turn away from the seductions of this chimera. Instead of the simplification that Ebbinghaus had hoped for, the nonsense syllable, for generations of researchers, merely screened the central problems of memory from inspection with the methods that Ebbinghaus had bequeathed us (Kintsch, 1985, p. 461).

. . . results based on meaningless stimuli are themselves meaningless when we attempt to understand how people learn and remember. This is the issue of ecological validity again, saying in essence that our traditional laboratory results do not apply to real-world situations that involve memory for meaningful material (Ashcraft, 1994, p. 210).

As the quotes above indicate, Ebbinghaus's decision to eliminate meaning as a confounding influence for the study of memory is now viewed as a major obstacle in the generalization of basic research to problems of remembering outside the laboratory (see Fig. 1). However, Ebbinghaus's influence was not limited to the field of memory. Every field of human performance has its nonsense syllables. For decision making, choice reaction time, and the book bag and poker chips problems are two examples of nonsense syllables. For motor control, tracking tasks and target acquisition tasks are examples of nonsense

syllables. For attention, visual and memory search tasks are examples of nonsense syllables. For problem solving, the Tower of Hanoi, and hobbits and orcs are examples of nonsense syllables. All of these tasks were chosen because they are context independent–the meanings are defined by arbitrary rules. The advantage is that the laboratory task is essentially a closed system–the effects of external influences, for example the differential knowledge and experiences of individual subjects, are minimized. Within this closed system, the logic for identifying causal relations between stimuli and responses is greatly simplified. However, the price paid for this simplification is that the causal relations discovered may have limited generality beyond the closed systems within which they were discovered. For example, research on tracking sums of sine waves in the laboratory may have no more relevance for understanding how pilots guide their aircraft to avoid threats and meet mission goals, than memory for nonsense syllables has for understanding eyewitness testimony.

The failure to address meaning and the consequent failure to impact design decisions are clearly seen in research on cognitive workload. The basic research on workload is based on studying every possible permutation of the various "nonsense" tasks. The implication is that real work is no more than a collection of these nonsense tasks–that flying an aircraft is simply a collection of various tracking, memory search, visual search, and decision tasks–and that a map of the patterns of interactions among these nonsense tasks will add up to a complete understanding of workload. It is clear that this research has not added up; and the waning interest and enthusiasm for "workload" as an area of study are evidence that there is growing skepticism that it ever will.

There has long been a tension between basic and applied research within the human factors community. The construct of situation awareness suggests a probable cause for this tension. The tension results from a basic research program that has sacrificed meaning to achieve experimental control. The construct of situation awareness demands that the problem of meaning be tackled head-on. Meaning must be considered, both in the sense of subjective interpretation (awareness), and in the sense of objective significance or importance (situation). In fact, I propose that a simple definition of SA might be the congruence between the subjective interpretation of an event and objective measures of the actual event. Here, event refers not to a slice in space and time, but to a complex problem unfolding within a dynamic task environment; and interpretation implies the integration of information from multiple sources and the ability to anticipate and respond appropriately to the problem. Strong correspondence between the interpretation and the objective situation means high situation awareness. Weak correspondence means low situation awareness.

Effective representations cannot be designed without an objective understanding of the meaning or significance of events within the context of a particular work domain. The meaning of data cannot be understood outside of a particular domain context. One thousand feet, 150 knots, an aircraft in the peripheral field, a flashing light, a screeching alarm, a 15° pitch–none of these pieces of data has a meaning outside the context of a particular work situation. It is impossible to understand how these elements can be structured into an effective representation without knowing their objective meaning. In fact, knowing what they mean implies an understanding of how they fit together within the larger picture. Identifying the objective criteria for how things fit together is a necessary, although not sufficient, step toward designing effective interfaces and training protocols. Meaning in this objective sense has not been effectively addressed by the information processing approach to basic research.

Thus, the answer to Question 2 is that a research program based on nonsense tasks will have little relevance for understanding situation awareness. Situation awareness is about how operators discover meaning within complex work domains. As such, situation awareness is not an isolated box within the information processing stream. Situation awareness refers to the adaptive relation between an actor and an environment. Just as with research on memory, a research program based solely on nonsense tasks will ultimately not be meaningful in terms of understanding situation awareness. In fact, such a research program will have little to say, in general, about cognition and human performance.

The search for meaning, in an objective sense, is clearly shaping the direction of situation awareness research. For example, Smith and Hancock (1995) address the need for "normative arbiters" of what's "right." In other words, we can't distinguish good or bad awareness (meaning as interpretation) without an objective measure of the situation (meaning as significance). Also, although not always obvious in the papers, the Situation Awareness Global Assessment Technique (SAGAT) developed by Endsley (1995) depends on extensive task analysis in the development of the probe questions to ensure that these queries address meaningful aspects of the situation. Finally, a number of researchers have noted the value of high-fidelity simulation as a basis for laboratory research on situation awareness (Gaba, Howard, & Small, 1995; Sarter & Woods, 1991). The high-fidelity simulations help to preserve the context so that the experimental manipulations (independent variables) and performance measures (dependent variables)

Continued on page 4

reflect meaningful dimensions of the work domain. Thus, the causal relations discovered are more likely to generalize to the work domain.

In sum, situation awareness is nothing new when considered relative to the application of cognitive engineering to systems design. It is simply an alternative way to articulate the need to design interfaces and training protocols so that operators can make informed decisions and actions when controlling complex systems. In this respect, I see no reasonable way to distinguish the problem of situation awareness from the problem of human performance in general. Designing to support situation awareness is designing to support human performance.

On the other hand, situation awareness is a challenge to the basic research foundations for human factors. It is a challenge to move beyond nonsense tasks, a challenge to face the implications of meaning for human performance, a challenge to develop a basic research program that generalizes beyond the laboratory to cognition in natural environments. A major concern has been that a basic research program that attempts to capture the meaningful contexts of natural situations will fractionate into a collection of specific answers to local problems and will consequently lose the ability to produce broad generalizations that are desirable for basic science. This, however, is a false concern. As evidence of this, consider the work of Rasmussen (1986); Rasmussen, Pejtersen, and Goodstein (1994); and the recent work of Hutchins (1995). Rasmussen's framework of skill-based, rule-based, and knowledge-based performance has proven to be an important framework for understanding expertise and human error. This framework is a generalization from research on troubleshooting in real work environments. Hutchins has recently published a detailed analysis of navigation as a work environment. This work leads to numerous generalizations about human and team problem solving. Here are two examples where researchers have immersed themselves in the specifics of particular work domains and have produced broad and powerful generalizations as a result.

Situation awareness challenges the basic research community to follow the path being blazed by pioneers such as Rasmussen and Hutchins. In this sense, situation awareness is a revolutionary new construct for human factors. It turns the classical view, that basic research leads and applications follow, upside down. With situation awareness, the concerns of designing effective human-machine systems will set the agenda that basic research in human performance and cognition will need to follow. ●

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John Flach, Ph.D., is an Associate Professor in the Psychology Department, Wright State University, Dayton, OH, and an Adjunct Research Scientist in the Armstrong Laboratory Human Engineering Division, Wright-Patterson AFB, OH.

GATEWAY

Calendar

April 10-12, 1996
Leicester, United Kingdom
1996 Annual Conference of the Ergonomics Society to be held at the University of Leicester. Contact the Conference Manager, The Ergonomics Society, Devonshire House, Devonshire Square, Loughborough, Leicestershire LE11 3DW, UK. Tel and fax: +44-509-234904.

April 14-18, 1996
Vancouver, British Columbia, Canada
CHI 96. Conference on Human Factors in Computing Systems. Contact Deborah Compere, CHI 96 Conference Administrator, Conference and Logistics Consultants, 703 Giddings Ave., Suite U-3, Annapolis, MD 21401. Tel: 410-263-5382, Fax: 410-267-0332, Email: chi96-office@sigchi.acm.org

April 22-24, 1996
Madison, WI, USA
Using Ergonomic Fundamentals to Analyze and Design Jobs, Work Methods, and Workstations. Workshop offered by the College of Engineering, University of Wisconsin. Contact Engineering Registration, The Wisconsin Center, 702 Langdon Street, Madison, WI 53706. Tel: 800-442-4214 or 608-265-3448, Fax: 800-462-0876 or 608-262-1299.

April 24-26, 1996
Madison, WI, USA
Advanced Ergonomics Application Workshop offered by the College of Engineering, University of Wisconsin. Contact Engineering Registration, The Wisconsin Center, 702 Langdon Street, Madison, WI 53706. Tel: 800-442-4214 or 608-265-3448, Fax: 800-462-0876 or 608-262-1299.

May 6-9, 1996
Houston, TX, USA
36th Biennial Meeting of the Department of Defense Human Factors Engineering Technical Advisory Group (DoD HFE TAG). Contact Sheryl Cosing, TAG Coordinator, 2444 Ridgehampton Ct., Reston, VA 22091. Tel: 703-758-2574, Fax: 703-757-1493, Email: scosing@arl.mil *The meeting is open to all government personnel and others by specific invitation.*

May 12-15, 1996
Palo Alto, CA, USA
ErgoCon '96. Silicon Valley Ergonomics Conference & Exposition. Contact Abbas Moallem, ErgoCon '96 Conference Chair, Silicon Valley Ergonomics Institute, San Jose State University, One Washington Square, San Jose, CA 95192-0180. Tel: 408-924-4132, Fax: 408-924-4153, Email: amoallem@isc.sjsu.edu, WWW: http://www-engr.sjsu.edu/ergocon96/

May 12-17, 1996
San Diego, CA, USA
SID '96. Society for Information Display International Symposium, Seminar, and Exhibition. Contact Terence J. Nelson, SID '96 Conference Chair, Bellcore, 445 South Street, M/S 2L241, Morristown, NJ 07962. Tel: 201-829-4865, Fax: 201-829-5885, Email: tnelson@faline.bellcore.com

June 3-7, 1996
Ann Arbor, MI, USA
Occupational Ergonomics. A short course offered by the University of Michigan. Contact Engineering Conferences, 200 Chrysler Center-North Campus, The University of Michigan, 2121 Bonisteel Blvd., Ann Arbor, MI 48109-9990. Tel: 313-764-8490, Fax 313-936-0253.

June 10-12, 1996
Ann Arbor, MI, USA
Ergonomics: Job Analysis and Field Studies. A short course offered by the University of Michigan. Contact Engineering Conferences, 200 Chrysler Center-North Campus, The University of Michigan, 2121 Bonisteel Blvd., Ann Arbor, MI 48109-9990. Tel: 313-764-8490, Fax 313-936-0253.

July 29-August 9, 1996
Ann Arbor, MI, USA
Human Factors Engineering. A short course offered by the University of Michigan. Contact Engineering Conferences, 200 Chrysler Center-North Campus, The University of Michigan, 2121 Bonisteel Blvd., Ann Arbor, MI 48109-9990. Tel: 313-764-8490, Fax 313-936-0253.

September 2-6, 1996
Philadephia, PA, USA
40th Annual Meeting of the Human Factors & Ergonomics Society, "Key to the Future." Hosted by the Delaware Valley Chapter in cooperation with the South Jersey Chapter. Contact HFES, PO Box 1369, Santa Monica, CA 90406-1369. Tel: 310-394-1811, Fax: 310-394-2410.

September 15-20, 1996
Stockholm, Sweden
25th International Congress on Occupational Health, "For a Good Working Life." Contact the Stockhom Convention Bureau, ICOH'96, Box 6911, S-102 39 Stockholm, Sweden. Tel: +46-8-736-1500, Fax: +46-8-348-441, Email: stocon@stocon.post.se

October 23-25, 1996
Stratford-Upon-Avon, United Kingdom
1st International Conference on Engineering Psychology and Cognitive Ergonomics. Contact Dr. Don Harris, Dept. of Applied Psychology, College of Aeronautics, Cranfield University, Cranfield, Bedford MK43 0AL, UK. Tel: +44-1234-750111 ext 5196, Fax +44-1234-750192, Email: icep@cranfield.ac.uk

November 11-13, 1996
Taipei, Taiwan, ROC
4th Annual Pan Pacific Conference on Occupational Ergonomics, "Ergonomics, Safety, Productivity, Quality." Contact Prof. Mao-Jiun J. Wang, Ergonomics Society of Taiwan, Dept. of Industrial Engineering, National Tsing Hua University, Hsinchu 30043, Taiwan, ROC. Tel: +886-35-715131 ext 3956, Fax: +886-35-722685, Email: est@ie.nthu.edu.tw, WWW: http://www.ie.nthu.edu.tw/~PPCOE/

June 29-July 4, 1997
Tampere, Finland
13th Triennial Congress of the International Ergonomics Association, "From Experience to Innovation." Contact Prof. Markku Mattila, Tampere University of Technology, Occupational Safety Engineering, PO Box 589, FIN-33101 Tampere, Finland. Tel: +358-31-3162-621, Fax +358-31-3162-671, Email: mattila@cc.tut.fi

Notices for the calendar should be sent at least four months in advance to:
CSERIAC Gateway Calendar, AL/CFH/CSERIAC Bldg 248, 2255 H Street, Wright-Patterson AFB OH 45433-7022

The COTR Speaks

Reuben L. Hann

Situation awareness is a topic that has increasingly captured the attention of the human factors and ergonomics community. In fact, a recent issue of *Human Factors* (Vol. 37, No. 1, March 1995) was dedicated to this topic and featured nine articles! An author of one of those articles, Dr. John Flach from Wright State University, has prepared the feature article on situation awareness. In it, he expresses his concern over the approach typically taken by many researchers and indicates why it may not be suitable for a complete understanding of situation awareness. John's opinions are sure to stimulate many of our readers!

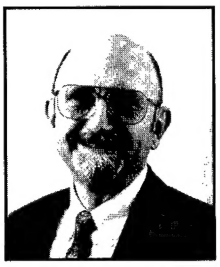
I am pleased to announce that we are resuming a column written by the CSERIAC Chief Scientist, Dr. Ron Schopper. This re-established column will be called *The CSERIAC Interface* to reflect Ron's desire to establish a dialogue with *Gateway* readers. I highly encourage you to share some of your thoughts with Ron as he tackles various issues relevant to the human factors and ergonomics community.

Besides the resumption of the Chief Scientist's column, we are beginning a new report called *Dear CSERIAC.* Every day CSERIAC is asked numerous questions pertaining to the application of human factors and ergonomics in work and leisure environments. This column will showcase many of the diverse questions asked of CSERIAC and the kinds of organizations who ask them. In addition, we are planning a product update column that will keep CSERIAC customers informed of changes or revisions to products they may have obtained through us.

Rounding out this issue, Suzanne Weghorst from the Human Interface Techology (HIT) Laboratory at the University of Washington has provided a glimpse of the exciting world of virtual reality. Her article is the first in a series of *Gateway* articles on laboratories around the world that enhance our understanding of human factors and ergonomics. If you would like to let our readers know about the work going on in *your* laboratory or research facility, please contact our Editor, Jeff Landis, and he will be happy to discuss what is necessary to provide such an article.

In closing, I would like to draw your attention to two upcoming meetings that are important to the human factors and ergonomics community. The first is the 36th Biennial Meeting of the Department of Defense Human Factors Engineering Technical Advisory Group (DoD HFE TAG) to be held May 6-9, 1996, in Houston, TX. The second is the 40th Annual Meeting of the Human Factors and Ergonomics Society to be held September 2-6, 1996, in Philadephia, PA. The *Gateway* calendar provides details on whom to contact should you be interested in attending one of these meetings. ●

Reuben "Lew" Hann, Ph.D., is the Contracting Officer's Technical Representative (COTR) who serves as the Government Manager for the CSERIAC Program.



The CSERIAC Interface

Aaron "Ron" Schopper

CSERIAC is about communicating information of interest to those working in the areas of human factors, human factors engineering, or ergonomics. The intent of this column is to provide a vehicle to serve that end. Hence, I am soliciting information regarding new tools, technologies, approaches, and issues (or fresh perspectives on older or enduring issues or concerns) from you, and I, in turn, will provide the information to the rest of our readers and, where appropriate, solicit their reaction. Send your input via any means, electronic mail (schopper@cpo.al.wpafb.af.mil), fax (513-255-4823) or regular mail (address on back cover).

When faced with the task of generating a new column, the very global nature of the work encompassed in the fields of human factors and ergonomics is somewhat of a "Catch 22" (and it's exacerbated when the Editor asks you to tell him what your column will be about–we had a rather energetic discussion regarding this; I'll recount some of it later). On the one hand, such breadth appears to represent a blessing. Given that our field can be represented as being just about anything that relates to how humans interact purposefully with their inanimate partners in the environment, it would appear that most everything would be fair game. However, if one is to bring a sense of focused purpose, integration, and organization to one's work (in my other job here, at CSERIAC, that is my chief responsibility), such breadth creates an increased need to make decisions, to impose constraints, and to limit one's scope. And that's what Jeff Landis, our Editor, was concerned about. He wanted to know what I was going to put in my column.

When initially approached about picking up this task (i.e., writing a regular column), I had a somewhat different perspective than Jeff. I wanted it to be a change of pace. Another grind-like requirement linked to tight suspenses and a need to produce clearly written, logical, well documented material was not what I had in mind; 60 hours a week is enough of that. Unfortunately, if you're the individual having overall responsibility for getting *Gateway* out (as Jeff is), you view the situation somewhat differently. Much like the position I take when wearing my other CSERIAC hat, Jeff wanted to know what I was planning to do, what would be my approach. "What are you about?" he said, "Tell me what the focus of this column will be." (I'm thinking that Jeff really just wants me to fill up these pages in a manner that won't embarrass him. But he's under pressure; we're a technical organization, and he wants a sense of organization and focus.) So I say, "Here in CSERIAC we're supposed to enhance and facilitate communication among our peers about things ergonomic. I'd like to foster that by inviting participation in a rather free-wheeling forum, a place where we can catch a glimpse of things to come–before they get here and pass us by or bowl us over. It is a highly technological age, Jeff, and progress is very rapid. I want this to be the place where we provide our readers with a preview of what's coming. Keep our readers informed! Help them in their work by providing state-of-the-art information, fresh perspectives, and new ideas! I'd like this to be the hardcopy version of the human factors internet!" (After pausing momentarily, I thought that last statement seemed a little like progress in retrograde; but I liked the sound of it, and kept on going, not giving him a moment to think.) "I want readers to get an appreciation of coming events: What's hot? What snot?" (Jeff interrupted: "That's 'What's not,' Ron; you've got to work on your diction." He's right, I guess I just get carried away sometimes.)

Well, I had hoped to get Jeff caught up in my enthusiasm and get past his concerns regarding things like purpose, definition, and "bounding" the column. But I was wrong. "Come on Schopper," he said, "What's this to be about?" We continued the discussion with varying degrees of emotion, enthusiasm, and intellect (probably in decreasing amounts, in the order listed, as time went on). After he realized that we had gone on for a longer period than he had planned, he pressed for closure. I could see that he had other things to do, and so I risked a definitive proposition. We finally agreed that we'd confine it to matters between "E" and "P," and he rushed off to meet his next suspense. Well I don't know what he thought I meant, (I admit, we did discuss the words "Ergonomic" and "Practical"), but I interpreted it to mean that I'd limit it to matters ranging from the "Empirical" to "Philosophical." So, we're off to a great start! The Editor and I have agreed on a set of conceptual constraints that will delimit the scope of my column from this point on. Ah, progress! (Let me hear from you!). ●

Aaron "Ron" Schopper, Ph.D., is the Chief Scientist for the CSERIAC Program Office.

GATEWAY

Want to See Your Name in Print? Provide Recognition for Your Organization or Laboratory?

CSERIAC is seeking high-quality, publishable material relating to the areas of human factors and ergonomics. Several types of publishable material are being sought.

We are developing a series of articles for publication in the *CSERIAC Gateway* what will highlight organizations, laboratories, and institutes (government, non-government, and academic) that perform research in the areas of human factors and ergonomics (see the first article in the series on page 9). If you would like to provide some recognition for your organization, we would be interested in obtaining an article that describes it. *Gateway* has a circulation of approximately 9,000 that reaches both national and international readers. Contact Jeff Landis, CSERIAC Publications Manager & Editor, for an author's kit.

Want to write a book? If you are interested in writing a book (or compiling and editing a book) relating to a timely human factors or ergonomics topic, contact Ron Schopper, CSERIAC Chief Scientist, for further information. We have some funding to support such efforts.

Contact Jeff Landis via email at *landis@cpo.al.wpafb.af.mil* or by telephone at 513-255-4099. Contact Ron Schopper via email at *schopper@cpo.al.wpafb.af.mil* or by telephone at 513-255-5215. Alternatively, contact either by writing to their attention at CSERIAC (see back cover for address).

Dear CSERIAC...

To show the diversity of support that CSERIAC provides, this column contains a sampling of some of the more interesting questions asked of CSERIAC. In response to these questions, CSERIAC conducts literature and reference searches, and, in some cases, consults with subject area experts. These questions have been compiled by David F. Wourms, Technical Inquiry Group Manager. If you would like to comment on any of these questions or issues related to them, please write to "Dear CSERIAC" at the address found on the back cover of *Gateway* or email Dave Wourms at wourms@cpo.al.wpafb.af.mil.

- A scientist from a national research center contacted CSERIAC to request information on the use of strobe lighting as a nonlethal weapon for crowd control.

- An Air Force researcher wanted to know what objective methodologies might be available for determining the workload of individuals who perform high-stress jobs, such as aircrews and air traffic controllers.

- A sergeant from the Army requested information concerning the application of virtual reality and visually coupled systems in the training of artillery gunners.

- A researcher from the Navy requested that CSERIAC identify any guidelines available to direct the design of an Instructor Operator Station for simulator training.

- An engineer from a well known research corporation wanted available information on the suppressive effects of direct and indirect artillery fire on infantry platoons.

- An engineer from a major vendor of advanced process control room designs requested information on inexpensive computerized human biomechanical models for use in designing operator workstations.

- A university student wanted to know what effect Raynauds Disease has on typing performance.

- A human factors engineer from a leading manufacturer of avionics displays wanted to know what research has been performed on the use of head-down glass cockpit displays for unusual attitude recovery.

Human Factors at the Human Interface Technology Laboratory

Suzanne Weghorst

Editor's note: This article is the first in a new series featuring human factors laboratories around the world. Contact us if you wish to provide an article about your organization. JAL

When Tom Furness left Wright-Patterson Air Force Base in 1989 to found the Human Interface Technology (HIT) Lab at the University of Washington, "virtual reality" was just breaking into the public consciousness. Since then the term (and the concept) has established itself as a cultural entity, and the HIT Lab has become widely recognized as a pioneer in its development.

While riding the wave of the current virtual reality craze, the HIT Lab mission is really much broader, that is, to empower people by creating better ways to interface with machines. Serving that mission are over 50 staff, graduate students, and laboratory affiliates from a wide cross-section of disciplines, including computer science, electrical engineering, mechanical engineering, industrial engineering, cognitive psychology, architecture, educational technology, medicine, and human factors. Together they are defining the newly emerging interdisciplinary fields of interface science and interface engineering.

In its first six years the Lab has established strengths in interface hardware, virtual environment software, and human factors. In addition to developing core interface technologies, Lab projects have converged around a set of application domains, most notably education, medicine, and design.

Some of the Lab's most noteworthy work is in the area of visual displays. Of particular note is the innovative Virtual Retinal Display (VRD) technology, which modulates and scans light directly onto the retina to form a coherent high-resolution image (see Fig. 1). VRD technology promises to provide the brightness, resolution, and form factor necessary to make augmented reality and other forms of head-coupled display commercially viable and suitable for a broad range of applications

Figure 1. Tom Furness, Founder and Director of the Human Interface Technology Laboratory, looking into a bench-top version of the virtual retinal display.

Concurrent with this development, the Lab has embarked on a program of research into relevant psychophysical and visual-vestibular phenomena, including various aspects of simulation sickness and visual-vestibular functioning. The goal of this line of research, of course, is to build safer and more effective visual display systems and virtual environments. A related effort looks at cognitive factors in virtual world design.

Spatial interface design is a second HIT Lab strength. Lab staff and students have gained extensive experience in virtual world building, using both commercial and in-house design tools. The Greenspace project, which included a week-long demonstration of an immersive environment shared concurrently by participants in Seattle and Tokyo, has established a Lab focus on collaborative interaction in distributed virtual environments. Working closely with the University's School of Architecture, the Lab has established a "virtual design studio" for distributed collaborative design. With sponsorship from the Air Force Office of Scientific Research, Lab researchers are also exploring the use of virtual environments to communicate situation awareness. And the Virtual Reality Roving Vehicle (VRRV or "verve") project, which brings virtual reality technology directly to children in the schools, has resulted in dozens of virtual worlds designed for specific curriculum objectives.

One currently fruitful area of research involves virtual reality simulation of "integrated interface systems" for medicine. Under Advanced Research Projects Agency sponsorship, the Lab is exploring techniques that allow physicians to configure and "try on" possible clinical information interfaces of the future. Drawing upon spatial interface concepts introduced by the SuperCockpit program, participants are able to grab and place data

Continued on page 10

objects, such as electrocardiogram (EKG) readouts and radiology images, anywhere within a simulated emergency room. The location and orientation of each object can be stabilizedwith respect to various points within the environment, such as the physician's head or body, the patient, or the room.

A high degree of presence is achieved for minimal computational cost here by "painting" the walls of the virtual emergency room with photographic textures acquired from an actual Level 1 trauma center (see Fig. 2). This participatory design process will provide the specification for a spatial medical interface system which can be tested clinically.

Finally, the HIT Lab is contributing to the advancement of the field by developing and demonstrating new interface concepts and metaphors. Among these are multi-modal interfaces which incorporate expert system interpretation of user behaviors across input channels; alternative input devices; collaborative augmented reality; and the "dyadic interface," which explores ways of greatly increasing the bandwidth between people and computers.

Laboratory Resources

HIT Lab research and development activities are supported by a very strong special library and on-line knowledge base. The Lab maintains an active FTP site at ftp.hitl.washington.edu, and its web pages can be found at http://www.hitl.washington.edu.

On the facilities side, the Lab maintains a comprehensive hardware and software infrastructure, including a variety of general purpose and specialized graphics machines connected to the internet via the campus network; numerous interface devices and software packages; optics and electronics labs; and several human factors research spaces. The Lab's external resources include various laboratories and collaborating academic departments at the University of Washington and elsewhere.

Figure 2. An immersive data interface configuration within a virtual trauma center.

Industrial Ties

In addition to its academic roots, the HIT Lab is uniquely tied to industry. Housed in the on-campus laboratories of the Washington Technology Center, the Lab's mission is expressly focused on developing and applying transferable technologies. Much of the Lab's infrastructure support comes from its 31-member Virtual Worlds Consortium, a collection of corporate partners with an interest in furthering the advancement of human-computer interface. ●

For additional information, contact the HIT Lab at:

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Mailing Address

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CSERIAC's objective is to acquire, analyze, and disseminate timely information on crew system ergonomics (CSE). The domain of CSE includes scientific and technical knowledge and data concerning human characteristics, abilities, limitations, physiological needs, performance, body dimensions, biomechanical dynamics, strength, and tolerances. It also encompasses engineering and design data concerning equipment intended to be used, operated, or controlled by crew members.

CSERIAC's principal products and services include:

- technical advice and assistance;
- customized responses to bibliographic inquiries;
- written reviews and analyses in the form of state-of-the-art reports and technology assessments;
- reference resources such as handbooks and data books.

Within its established scope, CSERIAC also:

- organizes and conducts workshops, conferences, symposia, and short courses;
- manages the transfer of technological products between developers and users;
- performs special studies or tasks.

Services are provided on a cost-recovery basis. An initial inquiry to determine available data can be accommodated at no charge. Special tasks require approval by the Government Technical Manager.

To obtain further information or request services, contact:

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